10-B NOISE AND VIBRATION: CONVEYANCE

FINAL ENVIRONMENTAL IMPACT STATEMENT

Brightwater Regional Wastewater Treatment System

APPENDICES



Final

Appendix 10-B Noise and Vibration: Conveyance

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Introduction

King County has prepared a Draft Environmental Impact Statement (Draft EIS) and Final Environmental Impact Statement (Final EIS) on the Brightwater Regional Wastewater Treatment System. The Final EIS is intended to provide decision-makers, regulatory agencies and the public with information regarding the probable significant adverse impacts of the Brightwater proposal and identify alternatives and reasonable mitigation measures.

King County Executive Ron Sims has identified a preferred alternative, which is outlined in the Final EIS. This preferred alternative is for public information only, and is not intended in any way to prejudge the County's final decision, which will be made following the issuance of the Final EIS with accompanying technical appendices, comments on the Draft EIS and responses from King County, and additional supporting information. After issuance of the Final EIS, the King County Executive will select final locations for a treatment plant, marine outfall and associated conveyances.

The County Executive authorized the preparation of a set of Technical Reports, in support of the Final EIS. These reports represent a substantial volume of additional investigation on the identified Brightwater alternatives, as appropriate, to identify probable significant adverse environmental impacts as required by the State Environmental Policy Act (SEPA). The collection of pertinent information and evaluation of impacts and mitigation measures on the Brightwater proposal is an ongoing process. The Final EIS incorporates this updated information and additional analysis of the probable significant adverse environmental impacts of the Brightwater alternatives, along with identification of reasonable mitigation measures. Additional evaluation will continue as part of meeting federal, state and local permitting requirements.

Thus, the readers of this Technical Report should take into account the preliminary nature of the data contained herein, as well as the fact that new information relating to Brightwater may become available as the permit process gets underway. It is released at this time as part of King County's commitment to share information with the public as it is being developed.

Purpose

The Brightwater Conveyance System would transport wastewater to and from the treatment plant and include the following primary components:

- Influent pipeline, primarily constructed in tunnels, for carrying untreated wastewater to the treatment plant
- Effluent pipelines, primarily constructed in tunnels, for carrying treated wastewater from the plant to the outfall
- Pump stations to lift the wastewater to higher elevations (depending on the alternative selected)
- Portals to support tunneling construction and contain certain permanent facilities for operation (depending on the alternative selected)

This technical memorandum contains the following sections:

Regulations and Criteria – Noise levels are regulated primarily by local jurisdictions (municipalities) along the proposed alignments of Brightwater Conveyance System Alternatives. Few jurisdictions regulate vibration levels; however, the Federal Highway

Administration has established vibration criteria that could potentially be used as a guide during construction of the proposed Brightwater Conveyance System.

Affected Environment – This section first summarizes the alignments and portal locations for the three Brightwater Conveyance System Alternatives. Second, site-specific information collected at the proposed portal locations is listed. The site-specific information includes existing noise sources, nearby land uses, topography, and the sensitivity of the sites to noise impacts.

Impacts – This section describes the potential noise and vibration impacts that could occur during the construction and operation of the proposed Brightwater Conveyance System. The potential for noise and vibration impacts is greatest at the portal locations; therefore, impacts at portals are emphasized.

Mitigation – This section summarizes general potential noise and vibration mitigation measures that have been used for construction and operation of conveyance systems. Many of these mitigation measures may be applicable to the Brightwater Project.

Regulations and Criteria

Noise

Noise Regulations

Noise levels are primarily regulated by local jurisdictions and the limits are specified in the municipal codes (Table 1). County or state regulations apply in unincorporated areas. The permissible noise levels are typically based on the following:

- Land uses of the noise source and the property receiving the noise
- Time of day (daytime or nighttime)
- Day of the week (weekday or weekend)

As shown in Table 1, construction activities during the daytime on weekdays are exempt from most local noise regulations. The hours defined as "daytime" vary by jurisdiction. For construction activities that take place other than during the daytime on weekdays, typical municipal codes limit noise levels. Noise levels are measured in "A-weighted" decibels (which refers to the noise that can be approximately heard by people).

If construction occurs outside the daytime/weekday period, noise variances can be obtained from local jurisdictions. The variances usually state restrictions on noise levels, rather than allowing a complete exemption from noise restrictions. The restrictions can include limiting the hours of operation for certain equipment, setting maximum permissible noise levels, restricting noise levels near sensitive areas (such as near schools or hospitals), and other restrictions. Lower noise limits are typically established for residential areas and night/weekend periods.

Table 1. Summary of Noise Regulations by Jurisdiction.

	T	I	T	T			
Jurisdiction	Applicable Regulations	Permitted Maximum Noise Levels	Daytime Construction Noise	Night/Weekend Construction Noise			
State	State						
Washington (Ecology)	WAC 173-60- 040	See Table 2					
Counties	1	1	1				
King	12.88, King County Code	See Table 3	May exceed designated levels by up to 25 dBA	For rural or residential districts, must be 10 dBA below permitted daytime levels from 10 p.m. to 7 a.m. weekdays, 10 p.m. to 9 a.m. weekends and holidays			
Snohomish	10.01, Snohomish County Code	See Table 4	Exempt ^a	Must be 10 dBA below permitted daytime levels from 10 p.m. to 7 a.m. weekdays, 10 p.m. to 9 a.m. weekends and holidays			
Municipalities			•				
Bothell	8.26, Bothell Municipal Code	Same as WAC 173-60-040 (see Table 2)	Exempt	Construction not permitted 6 p.m7 a.m. weekdays; after 5 p.m. Saturdays; Sundays and holidays			
Brier	8.08, Brier Municipal Code	Regulated as nuisance	Exempt	Construction not permitted 6 p.m 7a.m. weekdays; after 5 p.m. Saturdays; Sundays and holidays			
Edmonds	5.30 Edmonds Municipal Code	See Table 5	Exempt	Construction not permitted 10 p.m. – 7 a.m.			
Kenmore	12.88, King County Code	Same as King County (see Table 3)	May exceed designated levels by up to 25 dBA	For rural or residential districts, must be 10 dBA below permitted daytime levels from 10 p.m. to 7 a.m. weekdays, 10 p.m. to 9 a.m. weekends and holidays			
Lake Forest Park	8.24, Lake Forest Park Municipal Code	Regulated as nuisance	Exempt	Construction not permitted 9 p.m7a.m. weekdays; 9 p.m8 a.m. weekends and holidays			
Mountlake Terrace	8.20, Mountlake Terrace Municipal Code	Regulated as nuisance	Exempt	Construction not permitted 10 p.m7 a.m. (all days of the week)			
Shoreline	9.05, Shoreline Municipal Code	Regulated as nuisance	Exempt	Construction not permitted 10 p.m7 a.m. weekdays; 10 p.m9 a.m. weekends			
Woodinville	8.08, Woodinville Municipal Code	Same as WAC 173-60-040 (see Table 2)	Exempt	Construction not permitted 6 p.m7 a.m. weekdays; after 5 p.m. Saturdays; Sundays and holidays			
Woodway	Woodway Noise Ordinance	Regulated as nuisance	Exempt	Construction not permitted 7 p.m7 a.m. weekdays (9 p.m7 a.m. during summer); after 5 p.m. Saturdays; Sundays and holidays			

^a Except as otherwise stipulated under SEPA or permit conditions.

Bothell and Woodinville have adopted the Washington State noise level standards. The Washington Administrative Code (WAC 173-60-040) establishes noise level limits that vary according to the land use of the property where the noise source is generated and the land use of the property receiving the noise. These limits are administered by the Washington State Department of Ecology (Ecology). Ecology's maximum permissible sound levels are shown in Table 2.

Table 2. Ecology's Maximum Permissible Noise Levels (dBA)

	Land Use of N	loise Source		
Land Use of	Res	sidential	Commercial Industrial	
Receiving Property	Day	Night ^a		
Residential	55	45	57	60
Commercial	57	47	60	65
Industrial	60	50	65	70

^a Maximum permissible noise levels are 10 dBA lower than permissible daytime levels for residential receiving property between 10 p.m. and 7 a.m. Source: WAC 173-60-040

Other jurisdictions along the conveyance corridors that have their own maximum permissible noise levels include King County (Table 3), Snohomish County (Table 4), and the City of Edmonds (Table 5). Ecology's permissible noise levels are slightly higher than the King County, Snohomish County, and Edmonds permissible levels. The daytime permissible noise levels are the same for both King County (Table 3) and Snohomish County (Table 4). (Refer to Table 1 for nighttime permissible noise levels.)

Table 3. King County Maximum Permissible Daytime Noise Levels (dBA)

Land Use of Receiving	Land Use of Noise Source				
Property	Rural	Commercial	Industrial		
Rural	49	52	55	57	
Residential	52	55	57	60	
Commercial	55	57	60	65	
Industrial	57	60	65	70	

Kenmore has adopted King County's noise standards (Table 3). Other municipalities along the conveyance corridors (Brier, Lake Forest Park, Mountlake Terrace, Shoreline, and Woodway) have not adopted specific maximum noise levels, but do regulate noise on a "nuisance" basis and define construction noise outside of daytime hours as a nuisance subject to enforcement.

Table 4. Snohomish County Maximum Permissible Noise Levels (dBA)

	Land Use of Noise Source				
Land Use of Receiving Property	Rural Day/Night	Residential Day/Night	Commercial Day/Night	Industrial Day/Night	
Rural	49/39	52/42	55/45	57/47	
Residential	52/42	55/45	57/47	60/50	
Commercial	55/45	57/47	60/50	65/55	
Industrial	57/47	60/50	65/55	70/60	

Table 5. City of Edmonds Maximum Permissible Noise Levels (dBA)

Land Has of Description	Land Use of Noise Source			
Land Use of Receiving Property	Residential Day/Night	Commercial Day/Night	Industrial Day/Night	
Residential	55/45	57/47	60/50	
Business	57/47	60/50	65/55	
Commercial	60/50	65/55	70/60	

Noise Criteria

In addition to the state, county, and municipal noise regulatory requirements, federal documents provide guidelines for construction noise limits (refer to *References* section).

Vibration

Vibration is the oscillatory motion of ground and buildings caused by events or activities such as earthquakes, vehicles traveling on highways and railroads, and the operation of construction equipment and machinery. The effects of vibration include actual "feelable" or "perceptible" movement of the building floors, rattling of windows, shaking of items on shelves or hanging on walls, and rumbling sounds.

Vibration Regulations

Only three jurisdictions along the proposed alignments of the Brightwater Conveyance System Alternatives have regulations governing vibration due to construction activities, in addition to general provisions for vibration (Table 6).

Table 6. Summary of Vibration Regulations by Jurisdiction

Jurisdiction	Applicable Regulations
State	
Washington	None
County	
King County	None
Snohomish County	County Code has some provisions for mills operation, which may not be applicable on this project
Municipalities	
Bothell	None
Brier	None
Edmonds	17.60, Edmonds Municipal Code
Kenmore	None
Lake Forest Park	None
Mountlake Terrace	19.120.110, Mountlake Terrace Municipal Code
Shoreline	None
Woodinville	None
Woodway	None

Vibration Criteria

Construction vibration limits are often established to prevent damage to nearby structures. Table 7 lists typical levels of ground-borne vibration criteria. The human threshold of perception for vibration is approximately 0.0018 inch/sec, and a level of 0.0056 inch/sec is considered "distinctly perceptible." Background vibration is generally 0.0003 inch/sec; a typical bus or truck going over a bump could produce a level of 0.0032 inch/sec at a distance of 50 feet; bulldozers and other heavy tracked construction equipment could produce 0.0316 inch/sec vibration at 50 feet.

Table 7. Ground-Borne Vibration Impact Criteria

	Ground-Borne Vibration Impact Level (inch/sec)		
Land Use Category	Frequent Events ^a	Infrequent Events ^b	
Category 1: Buildings where vibration would interfere with interior operations, such as certain microelectronics manufacturing processes	0.0018	0.0018	
Category 2: Residences and buildings where people normally sleep	0.004	0.010	
Category 3: Institutional land uses with primarily daytime use such as schools and churches	0.0056	0.0141	

^a Frequent Events are defined as more than 70 vibration events per day.

Occirco: OCDO1 (1990)

^b Infrequent Events are defined as fewer than 70 vibration events per day. Source: USDOT (1998)

Affected Environment

Three alternative conveyance system alignments are being evaluated for the Brightwater Project:

- Route 9–195th Street
- Route 9–228th Street
- Unocal

The alignments and portal locations of these three conveyance system alternatives are shown in Figures 1 through 3.

Because most of the Brightwater Conveyance System would be associated with tunnels located between 40 and 450 feet underground, potential noise and vibration impacts are greatest at portal locations (portal siting areas). Portals provide access from the ground surface for launching and receiving the equipment used to construct the conveyance system tunnels. Construction activities at the portals would last between one and four years.

For the Brightwater Project, portal siting areas are 2,000-foot diameter (72-acre) areas where a minimum of one acre would be selected for portal construction (candidate sites). Between two and four candidate sites have been identified within or near each portal siting area.

The portal siting areas are designated as either primary or secondary. Primary portal siting areas would likely be used and have been identified along each corridor at intervals of approximately 20,000 feet. Secondary portals may be required based on geotechnical analysis performed during final design; however, these portals are not expected to be used. A decision on the need for secondary portals will not be made until final design is completed. If needed, secondary portals may be used for temporary ventilation, ground improvement, and/or grouting supply. If required, secondary portals would be located within approximately 10,000 feet of another primary or secondary portal. (Refer to Figures 1 through 3 for portal locations.)

The Brightwater Conveyance System Alternatives will require between four (Unocal Alternative) and seven (Route 9-228th Street Alternative) primary portals, depending on the alternative. Table 8 lists the portals associated with each Brightwater Conveyance System Alternative.

Table 8. Portals Associated with the Brightwater Conveyance Alternatives

Alternative	Primary Portal	Secondary Portal
Route 9-195th Street	5, 11, 19, 41, 44	23, 27, 45, 7
Route 9-228th Street	11, 19, 26, 33, 39, 41, 44	22, 24, 30, 37
Unocal	3, 7, 11, 14	5, 10, 12, 13

Existing noise levels along the proposed conveyance corridors vary depending on the nearby noise sources. Predominant noise sources along the conveyance corridors include major roadways (I-5, I-405, SR-522, and SR-104) and commercial and industrial activities. Sitespecific information for the proposed candidate sites are listed in Attachment A and summarized for each conveyance alternative below. (Note: Secondary portals are not

addressed because their use is not anticipated and they would require much less construction. Site-specific information for the primary and secondary portals is provided in Attachment A.)

Route 9-195th Street Alternative

The primary source of noise along the Route 9 195th Street Alternative is traffic from major roadways (SR-104, I-5, and I-405) either adjacent to or within the conveyance corridors. The SR-522 right-of-way is a major source of traffic noise within portal siting areas along the influent portion of the corridor. Kenmore Air Harbor, which generates noise from airplane landings and takeoffs, is also near Portal 11.

The existing noise conditions for the five primary portals and candidate sites associated with the Route 9-195th Street Alternative are summarized in Table 9.

Table 9. Existing Conditions at the Route 9-195th Street Conveyance Alternative Primary Portal Candidate Sites

Candidate Site Portal 11	Adjacent Land Use	Topography	Sensitivity to Noise (High, Medium, Low)	Existing Noise/Vibration Sources
A	Light industrial and commercial	Low area with gentle slope uphill to the north	Low	Commercial (heavy, e.g., truck) traffic and local traffic along Bothell Way and Juanita Drive NE; seaplanes
В	Light industrial and commercial	Low area with gentle slope uphill to the north	Low	Commercial (heavy, e.g., truck) traffic and local traffic along Bothell Way and Juanita Drive NE; seaplanes
С	Urban commercial and residential	Gentle slope uphill to the northwest	Medium	Local traffic from 68th Avenue NE and NE 181st Street; seaplanes
Portal 41				
A	Commercial—office park	Flat	Low	Commercial traffic and local traffic from North Creek Parkway and NE 195th Street
С	Commercial (office park), residential and park	Moderate uphill to the east, steep uphill just offsite to the east	Medium	Commercial and local traffic from 120th Avenue NE, NE Hollyhills Drive
D	Commercial (office park) and park	Flat	Medium	Commercial and local traffic along 120th Avenue NE

Table 9. Existing Conditions at the Route 9-195th Street Conveyance Alternative Primary Portal Candidate Sites (continued)

Candidate Site	Adjacent Land Use	Topography	Sensitivity to Noise (High, Medium, Low)	Existing Noise/Vibration Sources			
X	Urban commercial	Flat	Low	Traffic along I-405 and other nearby roads			
W	Residential and some open space	Slope uphill to the west	Medium	Traffic along I-405 and Beardslee Blvd.			
J	Commercial office park, vacant site north of the site ready to be developed	Flat; man-made stormwater drainage channel on the southeast side of the site	Medium	Traffic along North Creek Parkway and NE 195th Street			
Portal 44				-			
С	Rural, residential and forested	On steep slope uphill to the east	Medium	Minimal residential traffic			
D	Rural, residential and forested	Western portion flat; eastern third of site slopes slightly uphill to the east	Medium	Residential traffic from 80th Avenue NE & NE 195th Street			
E	Rural, residential open space, forested	Significant slope uphill to the west, on higher ground than NE 195th Street and adjacent residences	High	Residential traffic from NE 195th Street			
Portal 5				-			
В	Commercial	Gentle uphill to the northwest	Low	Heavy traffic on Ballinger Rd. NE, nearby I-5 traffic			
G	Commercial	Gentle uphill to the northwest	Low	Heavy traffic on Ballinger Rd. NE, Nearby I-5 traffic			
X	Commercial, residential	Gentle uphill to the northeast	Low	Heavy commercial and local traffic on Ballinger Way NE and 15th Avenue NE, Nearby I-5 traffic			
Portal 19	Portal 19						
А	Industrial, residential, and forested	Moderate uphill slope to the east	Low	Nearby railroad, truck traffic along Richmond Beach Drive NW			

Table 9. Existing Conditions at the Route 9-195th Street Conveyance Alternative Primary Portal Candidate Sites (continued)

Candidate Site	Adjacent Land Use	Topography	Sensitivity to Noise (High, Medium, Low)	Existing Noise/Vibration Sources
С	Industrial, residential, forested, and water (Puget Sound)	Bi-level (divided by Richmond Beach Drive), Flat (near sea level) with steep uphill slope just offsite to the east	Low	Nearby railroad, truck traffic along Richmond Beach Drive NW
E	Residential and water (Puget Sound)	Slight uphill slope to the east	Medium	Residential and truck traffic along Richmond Beach Drive NW

Route 9-228th Street Alternative

The major source of existing noise along the 228th Street corridor is traffic from SR-527 and SR-104, as well as roadway noise from 228th Street itself. Rights-of way along each of these roadways fall within portal siting areas. In addition, a private shooting range along 228th Street is a source of noise, particularly on weekends. I-5 and I-405 are also dominant local sources of background noise.

The existing noise conditions at the candidate sites at the seven primary portals associated with the Route 9-228th Street Alternative are summarized in Table 10.

Table 10. Existing Conditions at the Route 9-228th Street Alternative Primary Portal Candidate Sites

Candidate Site	Adjacent Land Use	Topography	Sensitivity to Noise (High, Medium, Low)	Existing Noise/Vibration Sources
Portal 11 –	Same as Route 9-195	th Street		
Portal 41 –	Same as Route 9-195	th Street		
Portal 44 –	Same as Route 9-195	th Street		
Portal 19 –	Same as Route 9-195	th Street		
Portal 39				
В	Rural residential, commercial and some open space	Gentle slope with hill rising to the northeast	Medium	Residential/ commercial and local traffic along 228th Street SE Fitzgerald Rd. and 29th Drive SE
С	Rural residential	Uneven, gentle slope uphill to the northeast	Medium	Commercial and local traffic along 228th Street SE and 31st Ave SE

Table 11. Existing Conditions at the Route 9-228th Street Alternative Primary Portal Candidate Sites (continued)

	·	1	ī			
Candidate Site	Adjacent Land Use	Topography	Sensitivity to Noise (High, Medium, Low)	Existing Noise/Vibration Sources		
D	Residential and commercial	Slight slope uphill to the north	Medium	Commercial and local traffic along 31st Ave SE		
Portal 33						
A	Rural residential and some vacant land	Moderate slope uphill to west	Medium	Local residential traffic		
С	Rural residential and some commercial	Mostly flat	Medium	Local traffic along 228th Street SW		
D	Rural residential	In low valley, slight slope uphill to northeast	Medium	Local traffic along Locust Way		
Portal 26						
А	Residential and some open space	Mostly flat	Medium	Local traffic along Lakeview Drive		
С	Commercial and residential	Gentle slope uphill to northwest, surrounding area is free of large hills	Medium	Commercial traffic on SR-99		
D	Residential, park, and forested	Hill to the east, relatively flat north, south, and west	High	Local traffic along 228th Street SW and 74th Avenue W		

Unocal Alternative

Major sources of noise along the Unocal corridor and at portal siting areas include freeways (I-405 and I-5) and major roadways (SR-522 and SR-104). These roadways have high volumes of traffic, which dominate the noise environment near these corridors.

The existing noise conditions at the candidate sites at the four primary portals associated with the Unocal Alternative are summarized in Table 11. (Note: secondary portals are not addressed because their use is not anticipated and they would require much less construction. Site-specific information for the primary and secondary portals is summarized in Attachment A).

Table 12. Existing Conditions at Unocal Alternative Primary Portal Candidate Sites

Candidate Site	Adjacent Land Use	Topography	Sensitivity to Noise (High, Medium, Low)	Existing Noise/Vibration Sources				
Portal 11 – S	ame as Route 9-195th	Street						
Portal 3	Portal 3							
D	Residential	Gentle slope uphill to the southwest	Medium	Local traffic along Edmonds Way				
E	Rural residential and commercial	Gentle slope uphill to the south, located in a low spot	Medium	Local traffic along Edmonds Way				
F	Rural residential	Moderate slope uphill to southwest	Medium	Minimal residential traffic				
Portal 7		•						
A	Residential, school, and light industrial	Track and field in northeast corner raised (20 ft) above baseball diamond and tennis court in west/southwest portion	Medium	Local traffic from 25th Avenue NE				
В	Residential, school (ball field), park	Sharp incline on southwest border	Medium	Local traffic from 25th Avenue NE and Ballinger Way NE				
С	Residential, school (ball field), park, and light industrial	Varied, Stream runs north to south dividing park in half	Medium	Local traffic from 25th Avenue NE				

Impacts

Construction

Noise

Many of the conveyance system features are common to the three Brightwater Conveyance System Alternatives, including pipelines and tunnels, portals, construction methods, and permanent facilities. The conveyance facilities would be mostly located underground. However, aboveground construction activities would be performed at the portal sites. Noise generated by construction at the portals could impact nearby residents and other people near the construction sites.

Construction Noise Impacts Common to All Conveyance Alternatives

No noise from tunneling would occur at portal locations and at microtunneling construction pits. No noise would be detectable in the areas between the portals and pits because construction operations would be at such depths that generated noise would be attenuated by the soil between the tunnel and the ground surface. Any open-cut construction would generate noise in the immediate vicinity of pipe installation operations.

Primary portals would initially be used for the construction of the conveyance facilities using tunneling techniques and subsequently to provide access to the tunnels for maintenance, inspection, and repair. Secondary portals, if used, would have limited construction activities in comparison to the primary portals. Noise levels during peak construction activities could reach as high as 76 dBA at distances of 250 feet from the construction area. Trucks entering and exiting the portal sites would generate noise levels as high as 90 dBA at 50 feet. These levels could temporarily disrupt outdoor conversation and other outdoor activities adjacent to the construction site.

The major elements of construction activities for the Brightwater Conveyance System, regardless of the alternative selected, would consist of the following:

- Mobilization
- Site preparation- grading, fencing and installation of noise barrier walls (if required)
- Portal construction excavation, pile driving or other methods for support of portals
- Tunneling excavation, initial lining, and final lining
- Conveyance facilities in portals construction and testing
- Demobilization

In addition to the specific equipment used, the potential noise impacts during construction would depend on the noise levels being generated, site characteristics, such as the nearby land use, the relative topography of the construction site, and the distance to the person hearing the noise – the receptor. For example, portal excavation in a residential neighborhood would have a higher potential impact than excavation in an industrial area or adjacent to a major highway. Noise levels in residential areas are typically lower than industrial areas; therefore, people in industrial areas are relatively less sensitive to increases in noise levels. In addition, surface construction activities would have a higher potential noise impact than construction activities that are far below the ground surface.

The total noise generated during construction would vary throughout the construction period and would depend on the mix of equipment and the proportion of time the equipment would be in use. The major sources of construction noise, primarily at the portal siting areas, would include:

- Trucking operations, such as slamming of dump truck tailgates, back-up beepers and revving the engines of the bucket loader
- Site equipment such as pile drivers, concrete trucks, dump trucks, cranes, and other types of heavy construction equipment
- Intermittent revving of the service crane engine
- Initial launching of the tunnel boring machine

- Construction truck traffic along the construction haul routes
- Ventilation blowers, which would operate 24 hours a day during tunnel excavation
- Periodic operation of compressor equipment and emergency (portable) generators

Regardless of the portal excavation support system used (driven or drilled piles and sheets, drilled piers, caisson, shotcreted ring, etc.) there would be heavy equipment in the portal area. Portal construction, for example, would typically require two crawler cranes, a 40-ton desander and slurry processing plant (or a 140-ton freezing plant), drilling rigs, etc. The typical maximum noise levels generated by commonly used construction equipment at a distance of 50 feet are shown in Table 12. The loudest noise generators are typically impact devices, such as pile drivers, clam shovels, and jackhammers.

Truck traffic during construction would also have the potential to cause increased noise levels at receptors along the construction access routes. The daily truck traffic would vary depending on the associated construction activities and the tunneling methods used. Typically, the trucks would be large horsepower tractor-trailers (18-wheel diesel trucks) that would travel on and off portal site. The heaviest truck traffic would usually occur in the morning.

Table 13. Construction Equipment and Maximum Noise Levels at 50 feet

Type of Equipment	Rating or Capacity	Engine Size (Horsepower)	Range of Maximum Sound Level at 50 feet (dBA)
Crawler tractor / dozer	101 to 250 hp	101 to 250	81 to 85
	251 to 700 hp	251 to 700	85 to 90
Front end loader	2.25 to 5 cu. yd.	116 to 299	82 to 86
	6 to 15 cu. yd.	300 to 750	86 to 90
Hydraulic backhoe	1.5 to 3 cu. yd.	131 to 335	82 to 86
excavator	3.25 to 7 cu. yd.	336 to 760	86 to 90
Grader	9 to 16 ft. Blade	60 to 350	79 to 86
Mobile crane 11 to 75 tor 10 ft. Boom		121 to 240	82 to 85
140-Ton Crane ^a	Not specified	Not specified	82 to 85
Pile Driver (Impact)	Not specified	Not specified	101
Pile Driver (Sonic)	Not specified	Not specified	96
Portable air compressor	400 to 2000 cfm at 100 psi	126 to 600	82 to 89
Trucks	100 to 400 hp	100 to 400	81 to 87

Source: Bolt, Beranek and Newman (1981)

At distances beyond 50 feet, these maximum noise levels would be reduced by 5 to 7 dBA for each doubling of the distance between the noise source and the receiver. For example, a hydraulic backhoe excavator of 7-cubic-yard capacity and 760 horsepower could generate noise levels of 83 to 85 dBA at a distance of 100 feet. The actual noise reduction would

^a Data added by GSA (2003)

depend on effects of terrain and line-of-sight barriers such as berms, retaining walls, opaque fences, and buildings.

Noise impacts could potentially occur during construction of the permanent facilities, such as pump stations, and in those segments of the conveyance that require open-cut construction. Noise impacts are not anticipated between the portals along the tunnel, because construction activities would take place well below the ground. Construction work at the portals may be expected to last from one to four years, and up to three years at pump station locations.

Route 9-195th Street Alternative

The potential noise impacts during construction for the Route-195th Street Alternative would depend primarily on the site characteristics (e.g., nearby receptors) (Refer to Table 9) and the construction activities at the portal locations. Table 13 summarizes the proposed construction activities that would influence the degree of noise impacts at the five Route 9-195th Street Alternative portals. Construction activities at working (or launching) portals would last between three and four years compared with only six months to 1.5 years at receiving portals (for example, Portal 5).

Table 14. Summary of Route 9-195th Street Primary Portal Construction Methods and Aboveground Permanent Facilities

Portal	Portal Vicinity	Construction Activity	Possible Portal Construction Method	Construction Duration (years)	Permanent Aboveground Facilities
5	NE 205th Street and Ballinger Way NE (SR-104)	Receiving portal	Concrete slurry walls	1.0	Odor Control Facility Dechlorination Facility
11	NE 175th Street and 68th Avenue NE	Working portal	Sheet piles	2.0 – 2.5	Odor Control Facility
19	NW 205th Street and Richmond Beach Drive NW	Working portal	Sheet piles	3.5 – 4.0	None
41	NE 195th Street and 120th Avenue NE	Working portal	Concrete slurry walls or jet grouting	3.0	Odor Control Facility
44	NE 195th Street and 80th Avenue NE	Working and receiving portal	Concrete slurry walls	3.5 – 4.0	Odor Control Facility

Relatively higher noise impacts could potentially occur at the portals that would be constructed using sheet piles. However, these portals (Portals 11 and 19) are located in

industrial and/or commercial areas. Portal construction would take approximately six months to one year.

The potential noise impacts could also be higher at Portal 44 because of the length of construction and the nearby rural residential land uses. The remaining Route 9-195th Street Alternative portals are primarily located in commercial areas, although some candidate sites at Portals 19 and 5 have residences located nearby.

Route 9-228th Street Alternative

The major differences between the Route 9-195th Street Alternative and Route 9-228th Street Alternative that would affect noise impacts during construction are:

- Route 9-228th Street Alternative would require construction activities at three additional portals along 228th Street (Portals 39, 33, and 26).
- Route 9-228th Street Alternative would not require construction at Portal 5.

The three portals along 228th Street are located primarily in rural residential land uses, with some candidate sites located within commercial areas. Construction activities at the portals along 228th Street are expected to last between one and 3.5 years. Sheet pile construction is not currently proposed for the three portals along 228th Street.

As shown in Table 14, the Route 9-228th Street Alternative would have the same noise impacts as the Route 9-195th Street Alternative at Portals 11, 19 and 41. Construction activities at Portal 44 for the Route 9-228th Street Alternative is expected to last three years as compared four years for the Route 9-195th Street Conveyance System Alternative.

Table 15. Summary of Route 9-228th Street Alternative Primary Portal Construction Methods and Aboveground Permanent Facilities

Portal	Portal Vicinity	Construction Activity	Possible Portal Construction Method	Construction Duration (years)	Permanent Aboveground Facilities
11	Same as Route 9	9-195th Street Alte	ernative		
19	Same as Route 9	9-195th Street Alte	ernative		
26	228th Street SW and Lakeview Drive	Receiving portal	Ground freezing	1.0	Dechlorination Facility Odor Control Facility
33	228th Street SW and Locust Way	Working and receiving portal	Concrete slurry walls	3.0 – 3.5	None
39	228th Street SE and 31st Avenue SE	Working and receiving portal	Concrete slurry walls	3.0	None
41	NE 195th Street and 120th Avenue NE	Working and receiving portal	Concrete slurry walls or jet grouting	2.5 – 3.0	Odor Control Facility
44	NE 195th Street and 80th Avenue NE	Working and receiving portal	Concrete slurry walls	3.0 – 3.5	Odor Control Facility

Unocal Alternative

The Unocal Alternative would require fewer portals than the Route 9 Alternatives, and with the exception of Portal 11, the portals would be in different locations (Figure 3, Table 16). The remaining three Unocal portals would be sited in mixed residential (Portals 7 and 3) and commercial (Portal 14) land uses.

The Unocal Alternative would include the construction of a pump station at Portal 11, and would, therefore, extend the construction period an additional 1.5 years compared with the Route 9 Alternatives. Portal 11 is located in an industrial area adjacent to Kenmore Air Harbor and SR-522, both of which are significant noise sources. As a result, noise increases from conveyance facility construction would not likely affect residences north of SR-522 in the vicinity of Portal 11. Microtunnel pits or open-cut trenches may also be constructed in the vicinity of Portal Siting Areas 11 and 14 in order to install connections between existing King County conveyance pipes to the new influent tunnel.

Relatively higher noise impacts could potentially occur at the portals that would be constructed using sheet piles (Portals 11 and 14). Portal construction would take approximately six months to one year.

Table 16. Summary of Unocal Alternative Primary Portal Construction Methods and Aboveground Permanent Facilities

Portal	Portal Vicinity	Construction Activity	Possible Portal Construction Method	Construction Duration (years)	Aboveground Permanent Facilities
3	SR 104 and 232nd Street SW	Working portal	Ground freezing	1.0	None
7	Ballinger Way NE and 25th Avenue NE	Receiving portal	Concrete slurry walls	3.0	Odor Control Facility
11	NE 175th Street and 68th Ave NE	Working portal	Sheet piles	3.5 – 4.0	Odor Control Facility Pump Station
14	North Creek Pkwy. and 120th Avenue NE	Receiving portal	Sheet piles	1.0	Odor Control Facility

Operation

Operational Noise Impacts Common to All Conveyance Alternatives

The following types of operational noise are associated with the aboveground facilities at portals:

• Noise from the operation of mechanical equipment, including pumps, blowers, fans, centrifuges, and co-generation engine generators

- Noise from standby electrical generation equipment (e.g., backup generators for pump stations during a power outage)
- Noise from electrical power controls
- Planned routine operation and maintenance activities. These planned activities would typically occur for a short time (weeks) and during the normal working hours
- Emergency operation, maintenance, and repair activities These are unanticipated conditions that may require nighttime work

Route 9-195th Street Alternative

The Route 9-195th Street Alternative would require the construction of permanent aboveground facilities at all five portal locations (Table 13). The potential operational noise impacts listed above could occur at these portal locations.

Route 9-228th Street Alternative

The Route 9-228th Street Alternative would have the same potential operational noise impacts as the Route 9-195th Street Alternative with the exception of an additional odor control facility and dechlorination facility at Portal 26 (Table 14). Permanent aboveground facilities at the remaining two portals (Portals 33 and 39) along 228th Street are not currently proposed; therefore, there would be no operational noise impacts at these portal locations.

Unocal Alternative

The Unocal Alternative could require odor control facilities at three portal locations (Table 15). In addition, the Unocal Alternative would also require the construction of a pump station at Portal 11. The pump station for the Unocal Alternative would be located in an industrial area near major sources of noise; therefore, significant noise impacts are not anticipated during operation. Pump station noise would be masked by the nearby heavy ambient sources of noise. Operational truck noise impacts are expected to be minimal at posted speed limits, and would be intermittently noticeable compared with other commercial traffic noise.

Vibration

Construction

Table 16 lists maximum vibration levels from equipment that may be used during construction of the Brightwater Conveyance System. Construction activities that could cause intrusive vibration include vibratory compaction and the use of jackhammers and tracked vehicles such as bulldozers. These vibration impacts are expected to be more of a nuisance than damage causing. Historic buildings that are prone to earthquake damage are most likely to be impacted by vibration from construction activities. Vibration from pile driving or the operation of other heavy construction equipment could also impact occupants in nearby buildings.

Table 17. Construction Equipment and Maximum Vibration Levels at 50 feet

Type of Equipment	Approximate Vibration Level at 50 feet (inches/sec) RMS	
Pile Driver (Impact)	Upper range	0.200
	Typical	0.080
Pile Driver (Vibratory)	Upper range	0.090
	Typical	0.022
Large Bulldozer		0.011
Loaded Trucks		0.010

Source: USDOT (1995)

Table 17 shows peak particle velocity (PPV) vibration levels for various construction activities at a reference distance (25 feet), as well as damage potential and perceptible distances for fragile (based on damage threshold of 0.20 inches per second) and extremely fragile (based on damage threshold of 0.12 inches per second) structures near the types of construction activities that could occur during construction of the project.

Table 18. Construction Equipment, Maximum Vibration Levels at 25 feet, Perceptible Distance and Damage Potential Distance for Buildings

	PPV ^a Vibration	ation Perceptible		Damage Potential Distance (feet)		
Activity	Levels at 25 ft (in/sec)	Distance (feet)	Fragile	Extremely Fragile		
Pile Driving/Sheet Pile Driving (Impact)	1.518	375	100	135		
Pile Driving/Sheet Pile Driving (Vibratory)	0.734	230	60	85		
Pavement Breaking	0.644	210	55	80		
Bulldozing	0.089	60	15	20		
Heavy Truck Traffic	0.076	50	13	18		
Jackhammers	0.035	30	8	11		

^a PPV Peak Particle Velocity

Sources: Wiss (1981), Asshto(1986), USDOT(1995)

As with noise, variances could be obtained to allow construction at night. Variances could include a vibration control plan that specifies nighttime vibration limits, and procedures for vibration monitoring and mitigation.

Temporary vibration impacts could potentially occur at the portals that would be constructed using sheet piles. Portal construction would take approximately six months to one year. Other portal construction methods, such as slurry wall and ground freezing, are not expected to result in vibration impacts. Vibration impacts during tunneling are not anticipated because of the depth of tunneling and the soil characteristics along the alignment.

Route 9-195th Street Alternative

Sheet-pile construction is currently proposed at Portals 11 and 19 for the Route 9-195th Street Alternative (Table 13).

Route 9-228th Street Alternative

Same as Route 9-195th Street Alternative.

Unocal Conveyance Alternative

Sheet-pile construction is currently proposed at Portals 11 and 14 for the Unocal Alternative (Table 15).

Operation

Vibration can occur from the operation of mechanical equipment at pump stations (Unocal Conveyance Alternative only). Most types and sizes of mechanical equipment that would be used during operation of the pump station facility are not capable of generating vibration at high enough levels to be detected at sensitive properties.

Mitigation

This section describes general mitigation measures that have been used to reduce or eliminate noise and vibration impacts and/or could be applied to the Brightwater Project. The specific mitigation measures will be based on the identified noise and vibration impacts following selection of the candidate sites and further analysis conducted for the final design.

Noise

Construction

Construction of the Brightwater Conveyance System would comply with local noise ordinances and regulations. Additional mitigation may be required for certain construction activities, for example, during peak construction periods for portals located near residential areas. Noise control measures would be stated in the construction specifications prepared for the Brightwater Project.

The following measures could potentially be used to mitigate noise impacts during construction of the conveyance system:

- Monitoring noise levels prior to construction. Existing sound levels near portal sites
 could be monitored to establish construction noise limits as a permit condition or
 contract requirement.
- Monitoring noise levels during construction at locations away from site to verify compliance with noise restrictions. Noise limits could be established for both equipment (50 feet away) and at the edge of the lot line. Reporting requirements could be established as well.
- Using noise barriers or curtains such as fencing, sound-limiting walls, and berms to deflect sound away from sensitive receptors.
- Specifying low-decibel equipment. For example, all construction equipment would be required to be equipped with well-maintained mufflers and other sound control devices comparable to or better than those originally supplied by the manufacturer.

- Establishing restrictions for back-up alarms (beepers), such as manually adjustable beepers, "only greater than ambient" back-up beepers for daytime operations. For nighttime operations (e.g., between the hours of 7 p.m. and 7 a.m.), backup alarms could be substituted with strobe lights or flag persons. These restrictions would apply to all vehicles contractor, vendors, and suppliers.
- Requiring ventilation and welding equipment to be placed in the portal, not on the ground adjacent to the portal.
- Providing power from existing sources to avoid the need for portable generators. Generators are potentially a large source of noise.
- Locating noisy equipment and performing noisy activities as far away from sensitive receptors as practical and using enclosures to muffle the sound.
- Limiting equipment idle times.
- Designating construction haul routes to minimize truck noise impacts on sensitive receptors.
- Limiting ventilation fan noise to acceptable levels through the use of enclosures or other sound barriers.
- Restricting the hours of performing certain construction activities/equipment (e.g., pile driving, front-end loaders).
- Employing enclosures, baffles and acoustical absorption as needed to control the noise produced by stationary equipment.
- Preparing a noise control plan. The noise mitigation methods would be identified in a
 noise control plan prepared by the contractor. The plan identifies the type of
 construction measures and proposed noise mitigation measures.
- Any construction activities required outside of exempt daytime hours would be conducted only under variance. Noise variances can include detailed noise control plans, limits on the hours of operation for noisy activities, maximum permissible nighttime construction noise levels, and maximum interior ground-borne noise.

In addition to mitigation used at the construction sites, additional measures could be implemented to mitigate impacts to residential properties and public use areas near portal operations. These measures include the following:

- Establishing a 24-hour hotline for the public to express complaints regarding noise impacts (and all other construction-related impacts). A noise complaint process (complaint logging procedures and responding to complaints) could be established. Complaints could be submitted to both the contractor's and county's construction office so that a representative could respond in a timely manner.
- Sending flyers to the community well in advance of construction to inform the community about the project, duration of construction activities, and types of noise (and vibration) generated, hours of operation, noise mitigation measures, and the phone number of the 24-hour hotline. Providing monthly or bi-monthly updates to keep the public informed about the progress of impending noisy activities. Informing residents and businesses within a large area, rather than just the area immediately over the tunnel and adjacent to the portals.

• Installing window treatments to improve the building's noise reduction capability or in extreme cases, temporary relocation of residents if conditions cannot be mitigated.

Operation

Project operation noise levels at the property line of the residential receptors would not exceed the appropriate noise level limits of the applicable codes for residential land use. The aboveground conveyance facilities at select portals (primarily odor control facilities) would be designed to operate at noise levels at or below the applicable regulated nighttime noise levels of the respective jurisdictions at the nearest noise-sensitive receptor.

For the pump stations, all equipment would be housed in buildings and in below ground galleries. Ventilation air intakes and exhausts of equipment rooms would be placed in a direction facing away from sensitive receivers whenever possible. Noise reduction rated acoustic louvers and duct silencers would be selected to reduce transmission of indoor noise to the outdoors.

Noise sources, such as engines, fans, and blowers, would be designed with noise reductions to limit noise impacts. Also, pumps, blowers, centrifuges, fans, and engine generators would be designed with the necessary vibration isolation and damping foundations to reduce transmission of force to the supporting structures to levels below the threshold of human perception at the nearest residences. Pump station ventilation systems design would include attenuation of fan noise and pump and motor noise to meet the specified noise level limits.

Vibration

Construction

Mitigation measures for vibration impacts during construction could include:

- Stating vibration limits in the contract documents and monitoring vibration during construction. The vibration monitors could be set to trigger on vibration events exceeding 50 percent of the limits. Surface vibration monitoring during tunneling could be conducted at approximately 1,000-foot intervals along the tunnel alignment, and at critical structures or buildings.
 - Vibration criteria could be based on type of equipment (e.g., tunnel boring machine, muck train) and/or time-of-day operations. Nighttime restrictions could be based on maintaining an acceptable environment for sleeping areas.
- Locating portals away from vibration sensitive buildings, such as concert halls, TV studios, recording studios, auditoriums, hospitals, theaters, and older historical structures, if possible.
- Pavement Breaking. To avoid any architectural damage (e.g., cracked plaster) to extremely fragile buildings, deep saw cuts could be made between areas of pavement breaking and the sidewalk areas in front of buildings. With this technique, groundborne vibration levels would be below the levels at which damage would occur.

- Pile Driving. There are no mitigation techniques that fully reduce vibration from pile driving operations. In areas where geological conditions permit their use, vibratory or sonic pile drivers could be used to reduce the vibrations associated with this activity. In addition, earthmoving and pile driving operations could be scheduled to avoid occurrence at the same time. Unlike noise, the total vibration level produced can be significantly reduced when each vibration source operates separately. In addition, at locations near fragile historic resources, additional measures could be followed to ensure that no damage occurs.
- Instituting measures to reduce vibration created by the tunnel boring machine, such as: (a) reducing cutter head speed, torque, or pressure (against the face) to change the energy from "cutting and breaking" the ground to "removal", (b) using a slurry of drilling mud in the cutter chamber to help loosen and remove materials.
- Establishing the 24-hour hotline for residents (as described above for noise) and documenting complaints and resolutions.
- Maintaining vibration-monitoring records.

Operation

Because long-term vibration impacts from operation of conveyance facilities is expected to be negligible, mitigation should be needed only for operating pump stations and selected odor control facilities. The design measures listed above for operation noise mitigation would also mitigate for potential operational vibration impacts.

References

ASSHTO. 1986. Standard Recommended Practice for Evaluation of Transportation Related Earthborne Vibrations. Designation: R8-81.

Bolt, Beranik and Newman, Inc. 1981. Noise Control for Buildings and Manufacturing Plants. Cambridge, MA.

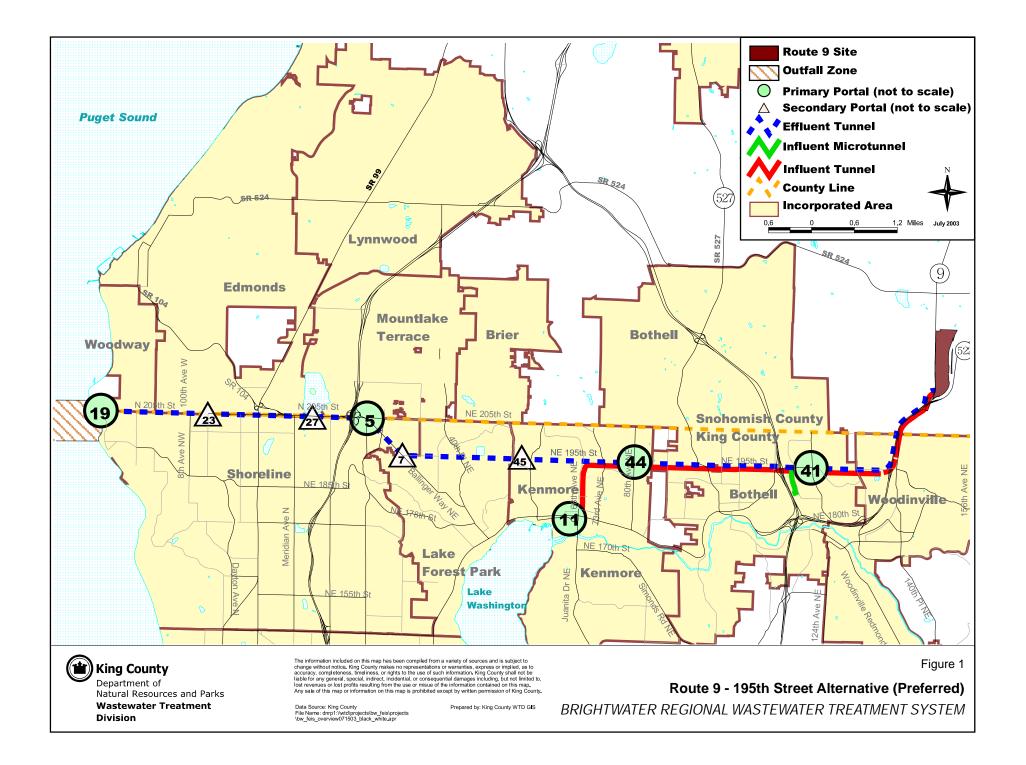
State of Washington. 1975. Maximum Permissible Environmental Noise Levels. Washington State Administrative Code (WAC), WAC 173-60-040.

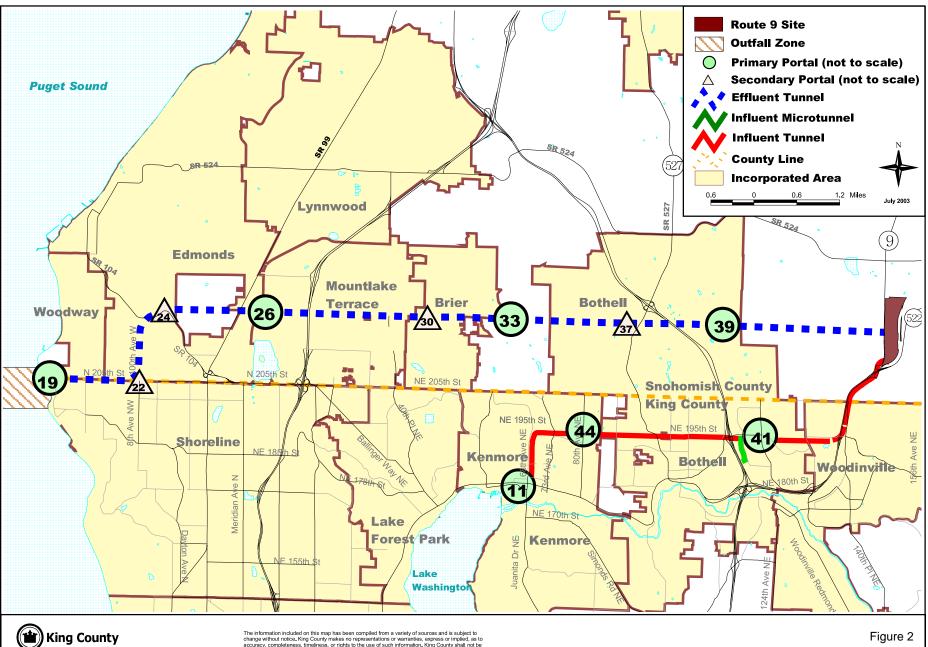
U.S. Department of Transportation, Federal Transit Administration. 1995. Transit Noise and Vibration Impact Assessment.

U.S. Department of Transportation, Federal Railroad Administration, Office of Railroad Development. 1998. High-Speed Ground Transportation Noise and Vibration Impact Assessment.

U.S. Department of Transportation, Federal Highway Administration. 2001. Procedures for Abatement of Highway Traffic Noise and Construction Noise, CFR, Part 772.

Wiss, John F. 1981. Construction Vibrations: State-of-the-Art. Journal of the Geotechnical Engineering Division, Proceedings of the American Society of Civil Engineers, 107 (GT2).





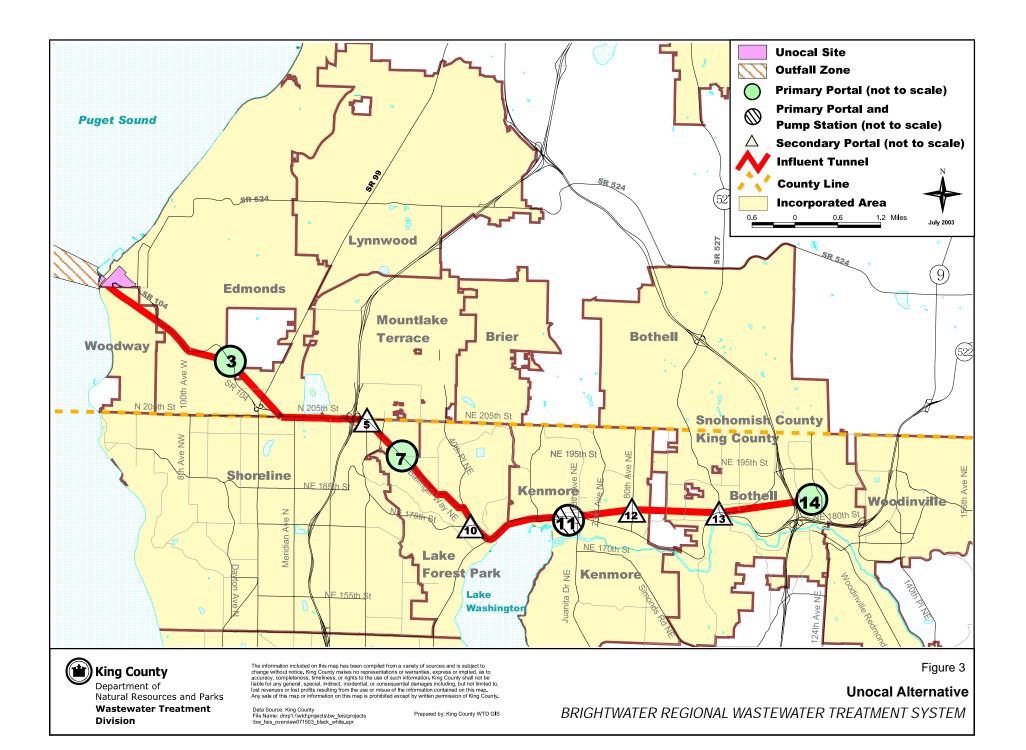
Department of Natural Resources and Parks **Wastewater Treatment** Division

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Route 9 - 228th Street Alternative

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Prepared by: King County WTD GIS BRIGHTWATER REGIONAL WASTEWATER TREATMENT SYSTEM



Attachment A

Existing Noise and Vibration Conditions at Portal Candidate Sites

Attachment A: Existing Noise and Vibration Conditions at Portal Candidate Sites

Candidate Site	Land use/ Receptors	Existing Sources of Noise /Vibration	Site Topography	Site Specific Comments
			Portal 3	
D	Single family residential	Local traffic along Edmonds Way	Gentle slope uphill to the southwest	Southeast portion of the site is wooded (vacant land), while western portion of the site contains single-family homes, stand of evergreens run along Edmonds Way from southeast to northwest, site is predominantly evergreen (approx. height 125 ft.) with a few scattered deciduous (approx. height 75 ft.)
E	Rural residential with commercial to the north	Local traffic along Edmonds Way	Gentle slope uphill to the south, located in a low spot	Site is predominantly evergreen (approx. height 150 ft.) with scattered deciduous (approx. height 60-80 ft.), trees form potential screen on western and southern borders
F	Rural residential	Minimal residential traffic	Moderate slope uphill to southwest	Forested site – mainly deciduous (approx. height 60-80 ft.), evergreens concentrated in southwest corner (approx. height 100 ft.), blackberry bushes and trees to the north, east, and west, road is narrow and winding - 15 mph corners
			Portal 5	
В	Commercial to the northwest, southeast, and northeast along Ballinger Road NE. Residential along perimeter of southern half of site	Heavy traffic on Ballinger Road NE, Nearby I-5 traffic	Gentle uphill to the northwest	Mostly impervious area- parking lot, storage and sales buildings, conifer trees run along perimeter of southwestern border (approx. height 100+ ft) forming a potential screen
G	Commercial to the northwest, southeast, and northeast along Ballinger Road NE. Residential along perimeter of southern half of site	Heavy traffic on Ballinger Rd NE, Nearby I-5 traffic	Gentle uphill to the northwest	Mostly impervious area- parking lot, storage and commercial buildings, conifer trees run along perimeter of southwestern border (100+ ft) forming a potential screen

Candidate Site	Land use/ Receptors	Existing Sources of Noise /Vibration	Site Topography	Site Specific Comments
X	Commercial to the northwest, southeast, and northeast along Ballinger Road NE. Residential along perimeter of southern half of site	Commercial and local traffic on Ballinger Way NE & 15th Avenue NE, Nearby I-5 traffic	Gentle uphill to the northeast	Gas station in northwest portion, commercial service in southeast portion, mostly impervious area, some evergreens along southern edge, 30 ft. deciduous trees between parcels
			Portal 7	
A	Residential, school to the north, King County Department of Transportation Utility to the west on Site B	Local traffic from 25th Avenue NE	Track and field in northeast corner raised (20 ft) above baseball diamond and tennis court in west/southwest portion. Uphill slope to the northeast	Baseball diamond in southwest corner, tennis court in northwest corner, track and field raised in northeast corner, fir trees (approx. height 50-70 ft.) on southern and eastern site borders form a potential screen from adjacent properties, deciduous trees in northeast portion (approx. height 70-100 ft.)
В	Commercial (WSDOT utility), school to the northeast, ball field to the east, bog and park to the north	Local traffic from 25th Avenue NE & Ballinger Way NE	Sharp incline on southwest border	King County Department of Transportation utility, mostly impervious area, mostly deciduous trees along western and northern borders of site that form a potential screen from adjacent properties
С	Residential, school to the northeast, ball field to the east, King County Department of Transportation Utility to the south on Site B	Local traffic from 25th Avenue NE	Varied, stream runs north to south dividing park in half	Park and bog area containing playground, mixture of coniferous and deciduous trees (approx. height 60 -100 ft.), narrow access path to western portion of site

Candidate Site	Land use/receptors	Existing Sources of Noise /Vibration	Site Topography	Site Specific Comments
			Portal 10	
А	Residential	Local traffic	Gentle slope with steep hill rising to the northwest	Trees surround the site and a cleared area
С	Residential and a church to the northeast	Local traffic	Gentle slope	Trees and grass in residential area. Site is in "Animal Acres Park"
D	Commercial to the south and southeast. Residential areas surround the remainder of the site.	Local traffic /commercial traffic along Ballinger Way NE	Gentle slope	The site is a parking lot with Windermere building on site. Trees in residential areas
E	Generally residential with an adjacent garage	Local traffic	Gentle slope	Some trees and houses on site
			Portal 11	
A	Light industry and commercial area with commercial north of NE Bothell Way	Commercial (heavy, e.g., truck) traffic, local traffic from NE Bothell Way & Juanita Drive NE, seaplanes	Low area with gentle slope uphill to the northeast	Mostly impervious area – buildings and parking lots, no trees, very open area, few trees around the site
В	Light industry and commercial area, commercial north of NE Bothell Way	Commercial and local traffic along NE Bothell Way & Juanita Drive NE; seaplanes	Low area with gentle slope uphill to the northeast	Unpaved parking lot, a few small deciduous trees (20-30 ft.) along southern and southwestern site borders
С	Urban commercial area surrounds site with residential area to northwest	Local traffic on 68th Avenue NE & NE 181st Street, seaplanes	Gentle slope uphill to the northwest	Shopping center parking lot with buildings on the north and east side, a few small deciduous trees along NE 181 st Street

Candidate Site	Land use/receptors	Existing Sources of Noise /Vibration	Site Topography	Site Specific Comments
			Portal 12	
С	Residential	Limited residential street traffic on 80th Avenue NE	Gentle uphill slope to the east	Mostly open area, trees concentrated around site borders - mostly deciduous, a few scattered evergreens, southern edge has larger trees (approx height 100-150 ft.)
Е	Residential	Limited residential street traffic on 80th Avenue NE & NE 185th Street	Gentle uphill slope to the east	Mostly open area – horse pasture, no trees on site, and deciduous trees off site along western edge
			Portal 13	
А	North of Sammamish River, commercial to the southwest, north, and northwest	Local and commercial traffic from Bothell Way NE & Woodinville Drive	Flat in a low-lying area	Site is a unpaved parking lot north of the Sammamish River, mostly evergreens (approx. height 30-40 ft.) with a few deciduous (approx. height 5-20 ft.) along western edge, deciduous (approx. height 5-20 ft.) along northeastern and southern edges park area for access to the Burke Gillman Trail
В	North of Sammamish River, Park and Ride Lot to the north on Woodinville Drive, commercial to the north and west, residential to the east	Local and commercial traffic from Woodinville Drive	Low-lying area with a slight uphill slope to the north	Commercial buildings (Fluke Metal Products) on site, a few deciduous trees on southern edge near Sammamish River
С	North of Sammamish River, commercial buildings surround site	Local and commercial traffic from Bothell Way NE, NE 180th Street & Woodinville Drive	Low-lying area with a slight uphill slope to the north	Mostly impervious area – building and parking lot, deciduous trees (approx. height 20-40 ft.) along NE 180th Street (southern border), remaining borders marked by deciduous trees with a few evergreens (approx. height 20-40 ft.), existing trees form potential screens along all borders

Candidate Site	Land use/receptors	Existing Sources of Noise /Vibration	Site Topography	Site Specific Comments			
			Portal 14				
A	Urban commercial (office park)	Commercial traffic along North Creek Parkway	Flat	Site is a baseball diamond with floodlights and paved pedestrian trail around the complex, scoreboard on concrete pad in southeastern corner, deciduous trees along western and northern borders, evergreen trees along eastern border, evergreen/deciduous mixture along southern border (approx. height 30-50 ft.)			
В	Urban commercial (office park)	Commercial traffic along North Creek Parkway	Flat	Site is a baseball diamond with floodlights and paved pedestrian trail around the complex, scoreboard on concrete pad on northern border, restroom facility in northwest corner, deciduous trees along western (approx. height 70 ft.) and southern borders (approx. height 25-30 ft.), evergreen/deciduous mix along eastern border (approx. height 40 ft.), all borders except northern may provide a screen for adjacent properties			
D	Urban commercial (office park) to the north and west, retail commercial to the south, residential to the east	Commercial traffic along 120th Avenue NE	Flat	Site is mainly grass, evergreens (20 ft.) along southern border and surrounding substation, deciduous within interior area (approx. height 10-12 ft.) and along western border (120th Avenue NE), parking and walkway of commercial services, trees form a potential screen on all but northern edge			
	Portal 19						
А	Industrial to the west, residential to the south and east, wooded area to the north	Nearby railroad, truck traffic along Richmond Beach Drive NW	Moderate uphill slope to the east	Wooded area - deciduous trees (approx. height 15-40 ft), small open area in southwest corner			

Candidate Site	Land use/receptors	Existing Sources of Noise /Vibration	Site Topography	Site Specific Comments
С	Industrial to the north, residential to the south and southeast, Puget Sound to the west, wooded area to the northeast	Nearby railroad, truck traffic along Richmond Beach Drive NW	Bi-level (divided by Richmond Beach Drive), Flat (near sea level) with steep uphill slope just offsite to the east	Site is on land fenced off as part of industrial activity, portion west of Richmond Beach Drive NW is near sea level with small deciduous trees (approx. height 30 ft.) lining above roadway, portion east of Richmond Beach Drive is mostly impervious – building and parking lot with a few small scattered deciduous and evergreen trees (approx. height 15-30 ft.), far eastern border may serve as a screen for adjacent property, large semi-trucks regularly use Richmond Beach Drive NW
Е	Residential to the north, south, and east, Puget Sound to the west	Residential and truck street traffic along Richmond Beach Drive NW	Slight uphill slope to the east	Site is Richmond Beach Pump Station, asphalt service road, grassy interior, fenced on all sides with tall bushes and trees, mainly deciduous (approx. height 20-40 ft.) in northern portion, evergreen/deciduous mix (approx. height 30-50 ft.) in southern portion lining Richmond Beach Drive NW, trees form a screen along eastern boundary of site
			Portal 22	
С	Residential	Minimal residential traffic along 8th Avenue NW	Moderate uphill to the east	Site is on Highland Park Estates - new houses north of stream (runs from southwest corner to northeastern portion of site), trees are predominantly evergreen (~150 ft.) with a few small deciduous used for landscaping (<20 ft.), some deciduous scattered among evergreen (approx. height 60-80 ft.), trees form potential screen from adjacent properties on all but eastern border
D	Residential with commercial area to the southeast	Minimal residential traffic along Firdale Avenue	Significant uphill to the southwest	Residential area with mature stand of evergreens running southeast to northwest across site (approx. height 150+ ft.), remaining trees are deciduous (approx. height 30-50 ft), trees form a potential screen along western/southwestern portion of site
E	Residential	Minimal residential traffic	Moderate slope uphill to the east	Residential with some evergreen trees (~100 ft), scattered deciduous used for landscaping (<20 ft.), trees may form screen along northern boundary
F	Residential	Light residential traffic	Slight slope uphill to the south, on top of a hill	Wooded northwest corner – mostly evergreen (~150 ft.), some deciduous running along site borders (<40 ft.), remaining site is residential area

Candidate Site	Land use/receptors	Existing Sources of Noise /Vibration	Site Topography	Site Specific Comments
			Portal 23	
A	Commercial with, multi-family (town homes) to the east	Residential traffic	Site is in a low spot with gentle slope uphill to the northeast	Shopping center with theater, commercial area has some landscaped deciduous trees (30 ft.), deciduous trees (20 ft.) border Firdale Avenue in southern portion of site, small section of evergreens (approx. height 100-150 ft.) and a few deciduous (approx. height 70-100 ft.) in northwest corner of site, northern border may serve as a potential screen for adjacent property (residential area to north)
D	Residential with commercial area to the southeast	Light residential traffic	Significant uphill to the southwest	Residential area with mature stand of evergreens running southeast to northwest across site (150+ ft.), remaining trees are deciduous (approx. height 30-50 ft), trees form a potential screen along western/southwestern portion of site a house
F	Residential	Light residential traffic	Slight slope uphill to the south, on top of a hill	Wooded northwest corner – mostly evergreen (~150 ft.), some deciduous running along site borders (<40 ft.), remaining site is residential area
			Portal 24	
А	Primarily residential with some commercial	Local/commercial traffic along Edmonds Way, construction at northern portion of site	Moderate slope uphill to north in southern portion, north half rises about 60 feet as a sharp ridge to the north	Residential development construction in northern portion surrounding cul-de-sac on top of ridge, deciduous trees (approx. height 75 ft.) along slope of ridge in southwestern portion of site, deciduous/evergreen mix (approx. height 100+ ft.) along eastern border (off-site) may form a screen, a few scattered deciduous (approx. height 15-20 ft.) in northern portion
В	Residential	Local traffic along 228th Street SW & 92nd Avenue W	Mostly flat	Site is a parking lot for church to the south, evergreens along the boundaries (north, east, west) are 50-75 ft. tall with some deciduous mixed in (<50 ft.), a few small landscaping deciduous trees (<10 ft.) line roadway (southern boundary), trees form a potential screen along north, east, and west boundaries of site
С	Primarily residential with some commercial	Local/commercial traffic along Edmonds Way	Moderate slope uphill to the south	Dense wooded area, mainly deciduous (approx. height 40-60 ft.) with a few evergreens (approx. height 70-80 ft.); entire parcel is wooded

Candidate Site	Land use/receptors	Existing Sources of Noise /Vibration	Site Topography	Site Specific Comments
			Portal 26	
А	Residential with open space to the south	Local traffic along Lakeview Drive	Mostly flat	Soccer field, park and park buildings, deciduous trees along western border (~50 ft.) form a potential screen for adjacent property, a few evergreens in far northwest corner of site (approx. height 50-100 ft)
С	Commercial to the north, south, and west along SR-99, residential to the east	Commercial traffic on SR-99	Gentle slope uphill to northwest, surrounding area is free of large hills	Site is mostly asphalt parking lot/driveway with large strip mall and small strip mall in southwest portion of site, half of the large strip mall is being remodeled, very few trees
D	Residential to the north, west, and southwest, ball field to the southeast and trees to the east	Local traffic along 228th Street SW & 74th Avenue W	Hill to the east, relatively flat north, south, and west	Dense wooded area – mostly mature evergreen and a few deciduous (approx. height 100-150 ft.), trees are in a corridor interrupted by power lines
			Portal 27	
А	Recreational area to the east, north and west, N 205th Street to the south	Heavy traffic along the arterial N 205th Street	Varied, gentle slope uphill to the south	Golf course with trees, grass, and shrubs, predominantly evergreen trees (60-150 ft) line fairway running southwest to northeast, a few scattered deciduous trees, trees form a potential screen to west and southeast, cemetery across N 205th Street
В	Residential north and west, cemetery south and east	Residential traffic	Hill rising to the south	Western portion is a densely wooded evergreen (approx. height 100-150 ft.) and deciduous (approx. height 50-70+ ft.) mixture, clearing on eastern portion
С	Residential north, west and south. Lake Ballinger to the east. Buildings are adjacent to the property	Residential/ church traffic	Located in a relatively low spot (cul-de-sac), gentle uphill slope to west	Residential area, large stand of evergreens in southwest portion of site (approx. height 70-100 ft.), a few small deciduous trees used for landscaping, church one block from site

Candidate Site	Land use/receptors	Existing Sources of Noise /Vibration	Site Topography	Site Specific Comments
			Portal 30	
А	Elementary school and residential	Residential/ school traffic	Near bottom of steep hill, site is flat	Ball field with no nighttime lighting, mainly deciduous along western edge (~70 ft.), trees become evergreen along northern edge (approx. height 150+ ft), open space in center portion, deciduous trees (approx. height 30-80 ft.) directly surround open space to east, north, and west, trees form a potential screen from adjacent properties to west, north, and possibly to the east
В	Urban residential	Residential traffic along 228th Street SW and 35th Avenue W	Moderate uphill slope to the east	Urban residential, trees along parcel borders, mixed evergreen/deciduous (approx. height 10-25 ft.) along 228th Street SW with a few 100+ ft. deciduous, 150+ ft evergreen and some deciduous between parcels, trees form a potential screen along southern edge only
С	Urban residential	Residential traffic along 228th Street SW	Sharp slope uphill to west	Dense mature wooded area, even mixture of evergreen and deciduous (approx. height 50-150 ft.)
			Portal 33	
A	Rural residential area with some trees to the north and east	Local residential traffic	Moderate slope uphill to west	Mature deciduous/evergreen mixture (approx. height 100-150 ft.) in northern portion, mainly evergreen (approx. height 50-100 ft.) scattered along western boundary, southern portion is cleared with houses, horse pasture, and private roads, trees form a screen to the north and possibly to the west
С	Rural residential with some trees	Local traffic along 228th Street SW	Mostly flat	Southern part of site is commercial and northern part is residential, mixture of evergreen/deciduous (approx. height 100-150+ ft.) along western border, deciduous (~100 ft.) along northern and eastern border, few trees within interior portion of site, trees form a potential border to east, north, and west
D	Rural residential with some trees	Local traffic along Locust Way	In low valley, slight slope uphill to northeast	Mature wooded area, mainly deciduous (approx. height 100+ ft.) and a few scattered evergreens, clearing in center of site extending north, trees form a potential screen on southern and western borders

Candidate Site	Land use/receptors	Existing Sources of Noise /Vibration	Site Topography	Site Specific Comments
			Portal 34	
A/B	Residential to the west, commercial along the north side of NE Bothell Way, bike path between NE 175th St and NE Bothell Way	Traffic NE Bothell Way, limited residential traffic on NE 175th St	Flat, lowland	Few trees, grass, just north of Swamp Creek Park
F	Residential to the southwest and southeast, commercial along the north side of NE Bothell Way, bike path between NE 175th St and NE Bothell Way	Traffic on NE Bothell Way	Flat, ridge with trees drops just beyond northeast boundary of site	Commercial buildings with asphalt parking lots
			Portal 37	
А	Urban commercial along SE side of 19th Avenue SE adjacent to site, residential with some trees surrounding site	Residential/ commercial traffic along 19th Avenue SE	Level	Site contains few trees, dense woods (mixture of evergreen/deciduous) off site to north and south and off to the west, housing development being built on hills to the east south of mall area
С	Urban residential	Local traffic along 9th Avenue SE & 228th Street SE	Gentle slope uphill to the west	Dense mixture of evergreen/deciduous (approx. height 25-50 ft.) along southern edge bordering 228th Street SE, similar interior mixture (approx. height 10-30 ft.), and northern portion is cleared of most trees and contains Extended Stay America
D	Urban residential	Local traffic along 9th Avenue SE	Gentle slope uphill to the west	Dense woods in eastern portion – evergreen/deciduous mixture (approx. height 100-150 ft.), western portion contains shorter shrubbery with some scattered evergreens (approx. height 80-100 ft.)

Candidate Site	Land use/receptors	Existing Sources of Noise /Vibration	Site Topography	Site Specific Comments
			Portal 39	
В	Rural residential west, south, and east. Office buildings across 228th St SE to the north	Residential/ commercial traffic along 228th Street SE, Fitzgerald Road, & 29th Drive SE	Gentle slope with hill rising to the northeast	Northern portion is mainly deciduous (approx. height 30-100+ ft.), southwestern portion becomes predominantly evergreen (approx. height 70-125 ft.), western portion is densely wooded, eastern portion is residential and contains few trees, trees form a potential screen in western portion
С	Rural residential	Local traffic along 228th Street SE & 31st Avenue SE	Undulating, gentle slope uphill to the northeast	Southwestern portion of site contains deciduous trees (approx. height 50-60 ft.), northwestern portion contains a mixture of evergreens (150 ft.) and deciduous (approx. height 80-100 ft.), clearing in center portion of site, trees form a potential screen along eastern and southern site borders
D	Rural residential	Local residential traffic along 31st Avenue SE	Slight slope uphill to the north	Site contains few trees, a few deciduous trees in center (approx. height 100+ ft.), small deciduous and shrubbery for landscaping use line property edges
			Portal 41	
A	Urban commercial (office park)	Commercial and residential traffic along NE 195th Street & North Creek Parkway	Flat	Interior of site is asphalt with concrete footings and contains no trees, perimeter lined with trees forming a potential screen for adjacent properties, northern edge is a mixture of evergreen (approx. height 10-20 ft.) and deciduous (10-50 ft) with a recreation path on top of a burm, eastern edge is a mixture of evergreen (approx. height 30-50 ft.) and deciduous (approx. height 100 ft.), southern and western edges are a mixture of evergreen/deciduous (approx. height 30-50 ft.)
С	Urban commercial (office park) to the north, south, and west, residential to the east, ball field to the southwest	Commercial and residential traffic along 120th Avenue NE, NE Hollyhills Drive, & Seattle Times access drive	Moderate uphill to the east, steep uphill just offsite to the east	Dense woods in southeastern portion – mixture of evergreen (approx. height 40-50 ft.) and deciduous (approx. height 30-100 ft.), grassy park area in northwestern portion with few trees (approx. height 20-30 ft.) - mostly deciduous and a few evergreen, pedestrian paths, benches, and gazebo, trees along border of 120th Avenue NE, parking lot, and NE 195th Street

Candidate Site	Land use/receptors	Existing Sources of Noise /Vibration	Site Topography	Site Specific Comments
D	Urban commercial, Office parks surround site to north, south, and east	Commercial and residential traffic along 120th Avenue NE, slight I-405 traffic	Flat	Baseball Diamond, trees line perimeter of site, northern and eastern edges contain deciduous trees (approx. height 20-25 ft.), southern and western edges contain a mixture of evergreen/deciduous (approx. height 40-50 ft.), trees form a potential screen along southern and western borders
х	Urban commercial	Traffic along I- 405, commercial traffic along North Creek Parkway	Flat	North Creek Pump Station
W	Residential with some open space	Traffic along I-405 and Beardslee Blvd.	Slope uphill to the west	Dense evergreen trees (approx. height 40-50 ft.) along west side of the site forming screen; mixture of deciduous and evergreen trees (approx. height 20-60 ft.) along south and southwest side of the site
J	Urban commercial office park	Traffic along North Creek Parkway and 195th Street NE	Flat; man-made stormwater drainage channel on the southeast side of the site	Northern and western border of the site have some evergreen (approx. height 20 ft.) forming partial screen; southeastern side contains a mixture of evergreens and deciduous along the drainage channel.
			Portal 44	
С	Rural residential, forested	Minimal residential traffic	On steep slope uphill to the east	Dense wooded area – deciduous/evergreen mixture (100+ ft.), proposed land action sign posted
D	Rural residential	Residential traffic along 80th Avenue NE & NE 195th Street	Western portion flat; eastern 1/3 of site slopes slightly uphill to the east	Open field with horse barn and houses, mostly deciduous trees on site borders (approx. height 20-100 ft.) forming a potential screen from adjacent properties; part of this site is listed as a park on the Thomas Guide Map, however, only private roads lead into the area, dense wooded area to the north, east, and south of site
Е	Rural residential to the south and west with open space to the north and forested to the east	Local residential traffic along NE 195th St	Significant slope uphill to the west, on higher ground than NE 195th St and adjacent residences	Southeastern portion contains a mixture of evergreen (approx. height 5-30 ft.) and deciduous (approx. height 20-40 ft.), western portion contains few trees, trees form a potential screen on all borders except south (along NE 195th Street)

Candidate Site	Land use/receptors	Existing Sources of Noise /Vibration	Site Topography	Site Specific Comments
			Portal 45	
A	Residential, church and daycare are located on west perimeter of site and 55th Avenue NE	Local traffic along 55th Avenue NE	Gentle uphill to the west	Site contains few trees, daycare and church in northwestern corner, trees along northern and southern borders are a mixture of evergreen and deciduous (approx. height 10-100+ ft.) and form a potential screen from adjacent properties
С	Residential, church and daycare to the east on 55th Avenue NE	Local traffic along 55th Avenue NE	Gentle uphill to the west	Wooded area, mixture of evergreen/deciduous (approx. height 50-150 ft.), dense in western portion, construction for residential development along northern edge of site.
D	Residential, Linwood park within site, church across NE 193rd Street to the north, gas station at corner of NE 193rd St & 55th Avenue NE	Local traffic along NE 193rd Street	Moderate slope uphill to the northwest	Site is mostly wooded, northern portion is Linwood park – contains mixture of evergreen/deciduous (approx. height 50-100+ ft), southern extensions contain mostly deciduous trees with a few evergreens, trees form a potential screen on all borders except north (along NE 193rd Street)